Year 3 SSC Coversheet

Title of your project	**Analysis of Cauda Equina MRI referrals between 2017 to 2020 – Scan requests, findings and positive and negative predictive factors**
Student Number	**C23006538**
Project Description and Aims: Please describe in brief what the broad purpose of your SSC project is.	**Primary aim:** Analyse referral trends from years between 2017 to 2020, assessing variations in volume in requests, key findings, and predictive factors of patients • Evaluate MRI scan outcomes – positive and negative predictive factors • Data is drawn from a defined cohort of referrals in the Cardiff and Vale Health Board to provide representative regional practice • Highlight opportunities to refine referral pathways to ensure appropriate imaging etiquette, the correct patients were identified as query CES and the proportion of patients who had CES
Educational Objectives: What did you intend to achieve from your project?	- Understand the way in which negative predictive factors may influence referrals for MRI scans in suspected discogenic CES - Acquire clinical experience in spinal surgery - Understand how positive and negative predictive factors may impact scan findings and patient care - To remain professional when handling patient data - To learn how to conduct a clinical service evaluation effectively

SSC Logistics: Describe here the activities you have undertaken during your SSC placement.	Week 1: I will conduct a lit review on and begin data analysis This week will consist of using platforms such as PubMed and papers provided by the spinal team in order to develop a deeper understanding as to what cauda equina is as well as the services currently available. This will be shared with the spinal fellow I have been assigned to work with me through this assignment and Prof. McCarthy. I will also begin looking through the patient data base that will underpin my project Week 2-4: Further data analysis and clinical experience in theatre This week will consist of working through the patient data base and drawing from information provided in WCP and synapse. My analysis includes looking at the symptoms the patients presented with and whether this resulting in a diagnosis of cauda equina - negative and positive predictive factors. I will have the opportunity to watch some procedures take place in UHW theatres. This will deepen my understanding of the surgical world but also bring the texts I read the week prior to life. Week 5: Statistical analysis on findings and begin drafting my poster and abstract This week will consist of working through the database and analysis as mentioned previously however, we will now also consider how the predictive factors impact the CES referral process. I will be supported through this section with the spinal fellow and Dr. McCarthy. In this week, I will begin working on my poster presentation and condensing what I have learnt thus far. Week 6: Continued analysis and abstract and poster finalisation
Was Ethics Approval required?	No
Word Count (for abstract and poster)	**Abstract: 428** **Poster: 855** The timeframe of the project has been amended to best represent the work done within the SSC project

AI Declaration	**If you HAVE used Gen AI:** I declare that I have used Generative AI software to support me in producing parts of this work. I have used Gen AI in line with the usage defined by the assessment guidance and have maintained academic integrity throughout my work. I have validated any Gen AI content through using reliable independent sources. I acknowledge my use of AI tools to (insert as appropriate): 1. Generate other aspect(s) of the assignment [Insert name of AI tool(s) and include brief details of how used] I used ChatGPT to create a macro for excel. This macro was used to flag patients who had MRI scans for CES. The macro was coded to look for important words in the report i.e. query Cauda Equina. The macro did not contain any patient details, and the data retrieval, analysis and documentation were done by myself.

Analysis of Cauda Equina MRI referrals between 2017 to 2020 – Scan requests, findings and positive and negative predictive factors

Introduction

Cauda Equina Syndrome is a rare but severe medical emergency requiring urgent diagnosis to prevent permanent neurological damage. Magnetic resonance imaging (MRI) is typically performed to confirm the diagnosis based on clinical features suggestive of CES. However, despite a stable prevalence of confirmed discogenic CES, the number of MRI referrals for suspected cases has increased between 2017 and 2024, placing growing demand on imaging services.

Method

This service evaluation aimed to analyse trends in MRI referrals for suspected CES between 2017 and 2024 and to assess the diagnostic value of presenting clinical features associated with confirmed discogenic CES. This may help to identify low-risk presentations that do not require urgent MRI.

A retrospective service evaluation was conducted on all patients referred for MRI scans from trauma and orthopaedics, emergency and neurosurgery emergency departments within University Hospital of Wales (UHW). Referral data was reviewed to determine which patients were scanned for suspected CES. For these cases, MRI reports were examined to determine if the patient had confirmed CES and the presenting clinical features they presented with. SPSS was used to examine trends in referral volume, scan-to-operation ratio and the predictive factors for CES associated with the patients. Patients were excluded if the clinical information was incomplete, if the report did not explicitly indicate the MRI was for suspected CES or if CES was attributable to non-discogenic causes.

Results

A total of 1156 MRI referrals were reviewed, of which 515 were requested for suspected CES of whom, 31 (6%) had confirmed discogenic CES. Sacral red flag symptoms, urinary and bowel dysfunction, saddle anaesthesia, perianal changes, anal tone abnormality, sexual dysfunction, were highly prevalent and occurred in 93% of patients. However, the mean number of sacral red flag symptoms were similar between both groups (CES 1.69 vs non CES 1.60). No individual symptom significantly distinguished confirmed CES from non-CES. Symptom clusters, including bladder or bowel dysfunction (OR 0.66, 95% CI 0.32–1.40), bilateral neurological symptoms (OR 1.72, 95% CI 0.83–3.53), objective neurological deficits (OR 1.32, 95% CI 0.65–2.71), ≥2 sacral red-flag symptoms (OR 1.28, 95% CI 0.62–2.62), and combined bilateral plus sacral signs (OR 1.39, 95% CI 0.68–2.85), were not significantly associated with confirmed CES. Scan to CES diagnosis stood at 1 confirmed CES case per 17 cases.

Conclusions

Symptom based assessment demonstrates poor discrimination in determining CES status. Red flag symptoms were common but not specific to CES. This results in low diagnostic yield for MRI however, the correct patients were identified in needing scanning. Ongoing data collection will

allow more robust evaluation of predictors and service performance. The next stage of the project will be to analyse years up to 2024 which includes analysis of trends after CES protocols were installed, namely the GIRFT National Suspected CES Pathway.

Analysis of Cauda Equina MRI referrals between 2017 to 2020 – Scan requests, findings and positive and negative predictive factors

Naadu Aryee and Professor Michael McCarthy

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OBJECTIVES

Primary aim: Analyse referral trends from years between 2017 to 2020, assessing variations in volume in requests, key findings, and predictive factors of patients

- Evaluate MRI scan outcomes – positive and negative predictive factors
- Data is drawn from a defined cohort of referrals in the Cardiff and Vale Health Board to provide representative regional practice
- Highlight opportunities to refine referral pathways to ensure appropriate imaging etiquette, the correct patients were identified as query CES and the proportion of patients who had CES

INTRODUCTION

Cauda equina syndrome (CES) is a serious medical emergency resulting from the compression of a series of nerves known as the cauda equina (1). Symptoms of the syndrome can vary from patient to patient however symptoms include back pain, sciatica – usually bilateral in nature – perianal numbness, reduced anal tone, saddle anaesthesia and sexual dysfunction (2).

CES requires urgent medical attention as compression for too long can lead to permanent neurological deficits. Due to the vague and nonspecific symptoms, CES can be missed or overly tested for via MRI (3). Furthermore, between these years, there was a lack of cohesive definitions for CES and their symptoms; what does perianal numbness mean to the physician or to the patient reporting the symptom, for example (4).

This project investigates factors underlying the rise in MRI referrals and aims to identify collections of symptoms that negatively predict CES. This may support more effective triage, improve diagnostic efficiency while reducing unnecessary imaging and healthcare burden.

METHOD

A retrospective study was conducted at the Emergency Division of the University Hospital of Wales (UHW), including referrals from Orthopaedics and Trauma, Neurosurgery, and Emergency Medicine. All urgent MRI scans performed for suspected cauda equina syndrome (CES) were retrieved from radiology records. Reports containing the indication "query CES" or equivalent wording were included, and patients were grouped by year of presentation to enable temporal comparison of referral patterns.

A custom macro, developed using an AI assistant, was used to label MRI reports indicating suspected CES. No patient-identifiable information was used or accessible to the AI at any stage. Despite automated labelling, all MRI reports were subsequently reviewed and analysed manually.

Clinical data were extracted and coded for the following parameters: presence or absence of discogenic CES; whether the patient underwent subsequent spinal surgery regardless of CES status; and documented presenting symptoms. Symptoms assessed included:

- ***Urinary and faecal dysfunction***
- ***Saddle anaesthesia***
- ***Perianal numbness***
- ***Anal tone abnormalities***
- ***Sexual dysfunction***
- ***Back pain***
- ***Sciatica and radicular pain (bilateral or unilateral; side specific***
- ***Weakness (bilateral or unilateral; side specific)***
- ***Reduced power***
- ***Sensory changes***
- ***Paresthesia***
- ***Reflex changes***
- ***Gait disturbances***
- ***Presence or absence of CSF on MRI***

Exclusion criteria comprised MRI referrals not stating "query CES" or equivalent wording, CES not discogenic in origin, vague or absent clinical documentation, and cases outside the predefined study timeframe.

Descriptive statistics summarised patient characteristics, symptom prevalence, and referral trends. Comparative analyses between patients with and without confirmed CES were performed to identify negative predictive factors. Statistical significance was set at $p < 0.05$.

Ethical approval was obtained prior to data collection. All data were anonymised and handled in accordance with relevant data protection regulations.

RESULTS

A total of 513 patients underwent MRI for suspected CES, of whom 31 (6.0%) had confirmed CES. Sacral red-flag symptoms (urinary and bowel dysfunction, saddle anaesthesia, perianal changes, anal tone abnormality, sexual dysfunction) were present in 478 patients (93%), while 35 patients (6.8%) had no documented sacral red flags. No individual symptom significantly distinguished patients with confirmed CES from those without.

The presence of any sacral red-flag symptom was associated with lower odds of confirmed CES (OR 0.36, 95% CI 0.13–1.00), reflecting the high prevalence of these symptoms in the non-CES population. The mean number of sacral red-flag symptoms was similar between groups (CES 1.69 ± 1.09 vs non-CES 1.60 ± 0.86).

Symptom clusters, including bladder or bowel dysfunction (OR 0.66, 95% CI 0.32–1.40), bilateral neurological symptoms (OR 1.72, 95% CI 0.83–3.53), objective neurological deficits (OR 1.32, 95% CI 0.65–2.71), ≥2 sacral red-flag symptoms (OR 1.28, 95% CI 0.62–2.62), and combined bilateral plus sacral signs (OR 1.39, 95% CI 0.68–2.85), were not significantly associated with confirmed CES.

The ratio of scans to subsequent operations was 14.3%.

Overall, individual symptoms and symptom clusters demonstrated poor specificity for confirmed CES in this scanned population.

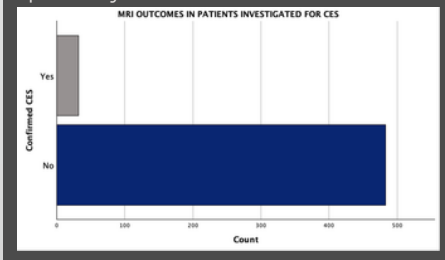

Figure 1 : MRI outcomes in patients investigated for suspected CES

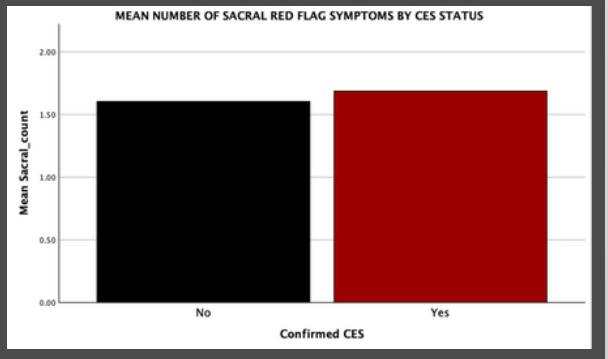

Figure 2 : Prevalence of sacral reg flag symptoms in the scanned cohort - CES confirmed and CES absent

CONCLUSION

This service evaluation concluded that individual symptoms, such as *only* urinary dysfunction, did not significantly distinguish patients with confirmed CES than without. Similarly, combinations of symptoms - bilateral symptoms, neurological deficits, sacral red flags - were not significantly associated with confirmed CES. Sacral red flags were highly prevalent in the scanned patients. This suggests that commonly cited red flag symptoms were sensitive in prompting investigation but lack specificity in true CES. The results indicate that symptom-based assessment, especially those that are subjective, have limited discrimination value for diagnosing CES by MRI. Ongoing data collection is expected to increase the number of confirmed cases and improve statistical power, allowing more robust evaluation of potential predictors and service performance over time

References
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